

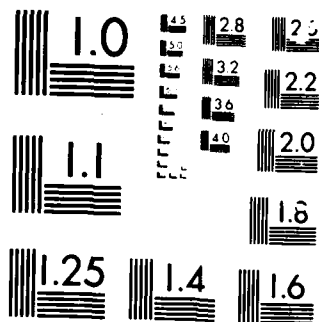
**SOME TENTATIVE IDEAS ON DEVELOPING OUR LOW-ALLOY AND
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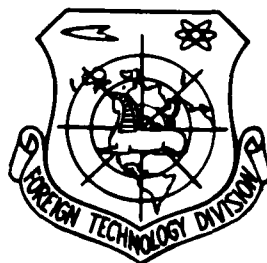
FOREIGN TECHNOLOGY DIVISION



SOME TENTATIVE IDEAS ON DEVELOPING OUR LOW-ALLOY AND ALLOY STEEL

by

Chuandian Zhou



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SOME TENTATIVE IDEAS ON DEVELOPING OUR LOW-ALLOY AND ALLOY STEEL

Chuandian Zhou
(Ministry of Metallurgical Industry)

The decision that every effort will be made to develop low-alloy and alloy steel made by the State Council has great strategic significance; it shows that our steel industry is shifting its emphasis to quality control and increasing economic profits, especially benefiting society.

In order to create a new face for our low-alloy and alloy production, some thoughts on correct technical policy making will be presented which, I hope, will serve as a reference for the next decision making steps.

1. Targets and level of development

In order to quadruple our gross national product by the end of this century, in order to innovate and improve the technique of our national economy and gradually make the four modernizations come true, meanwhile achieving our strategic target of doubling the total output of our steel industry and more than doubling the economic profits, faster speed and better quality should be emphasized in the development of low-alloy and alloy steel. This is an important technical and economic decision in developing our economy and material industry, or we can say it is an important strategic decision of our country.

Compared with ordinary carbon steel, low-alloy and alloy steel are qualitatively better and economically more profitable. First of all, they are more profitable than carbon steel. For example, it was reported abroad that on average 30% amount of metal was saved by using low-alloy steel instead of carbon steel. By the year 2000, if we could produce 15 million tons of low-alloy steel, which would be equivalent to more than 21 million tons of

ordinary carbon steel, the metal saved would be equal to the whole output of the Baoshan Iron and Steel Complex. Moreover, they have their own special value of applications which could not be substituted in our four modernizations. Therefore, to produce more alloy and low-alloy steel has been considered an indispensable way to develop the economy and technology in an era of atomic energy, space travel and electronics by all the industrialized countries.

It is believed that the strength of the economy, and science and technology of a country is related to how much quantity, how many species and what quality alloy and low-alloy steel it can produce. In order to double our steel production and to more than double profits, we also have to develop low-alloy and alloy steel more rapidly.

In 18 years from now, in order to develop low-alloy and alloy steel, we have to take the initiative and overcome our lack of planning. Therefore, a practical development target and level should be set up and a correct technical policy should be stipulated which can be used as guides to steadily achieve our target. The development target and level, according to my opinion, can be determined by the following four factors:

(1) The low-alloy and alloy steel proportions should increase greatly.

The production of low-alloy and alloy steel should be increased much faster than that of carbon steel. By the year 2000, production of steel will be doubled compared with that of 1980; an average 3.5% increase every year will be expected. Our preliminary consideration is to increase alloy steel proportionately from less than 5% to 10%, and low-alloy steel proportionately from less than 9% to more than 20%; the proportion of their sum from less than 14% to more than 30%. That means the average rate of increase will amount to 7.4% every year.

(2) Product varieties and quality should be brought up to the world level of the 70's at the beginning of the 80's.

As far as product variety is concerned, we should produce almost all the alloy steel we need, including alloy-structural steel, stainless steel, bearing steel, high speed tool steel, alloy tool steel, spring steel, cold rolling silicon steel, high temperature alloy, precision alloy, special metal material, etc. We also should try to export the above-mentioned products. Imports and exports will exist concurrently. The first priority is to meet the needs of the mechanical industry, defense industry, oil chemical industry, all kinds of new developing industries, along with technical innovation of our national economy and the need to replace technical facilities. We should produce enough low-energy steels including low-alloy steel oil pipes, steel rail, all weather steel plates, steel reinforcing bars and all kinds of high intensity steels to meet the large demand from different branches of industry especially concerned with energy, transportation, architecture, mining, light industry and civil use. A product varieties system of Chinese characteristics should be established both in low-alloy and alloy steel. Steel plates, pipes, bars and strips proportions of the total steel products will increase from 15% to 40% by the year 2000. We should adopt the technical policy of "using less, achieving more" to put great effort in developing highly efficient steel products, such as low-alloy steel, heat treated steel, cold rolled steel, economic shaped steel plates and powder metallurgy products, etc. We want to use less steel to do more things. The product quality should be brought up to the world level of the 70's and the beginning of the 80's. The product quality of key factories should be comparable to that of international standards. More good brand products should be produced to compete in international markets. Great effort should be concentrated in high precision and high purity of the products in order to achieve the targets of high quality, high use value and high economic profits.

(3) A fundamental change of technique, technology and equipment.

The backward technique, technology and equipment of the 50's and 60's should be replaced by that of the advanced 70's and 80's. The techniques of smelting, casting, rolling and heat treatment which are popularly used in developed countries to produce alloy and low-alloy steel should be popularized and put in a complete set so that a comprehensive production capability could be formed. The advanced techniques which have already been introduced into our country should be well digested. Our own inventions and technical innovations should be developed and improved to reach the level of the 70's. The techniques which are still waiting to be developed internationally should be investigated and developed as technical storage. In summary, the alloy and low-alloy production in our country should be switched to the advanced technical level of the 70's and 80's through technical import and introduction, technical innovation and investigation.

(4) The main technical economic indices reach a new level.

Main technical economic indices, such as energy consumption per ton of steel (including electricity consumption per ton steel if an electric furnace is used), the rate of finished steel products, alloy raw material use rate, metal consumption per ton steel, casting efficiency, rolling efficiency, life time of product precision, purity and metallographic structure and financial indices, such as production costs, turn over of capital and profit rate, should all reach the international or national level, so that the economical benefits of the whole steel industry by the year 2000 will be twice that of 1980.

In order to achieve the above-mentioned targets, a series of technical policies should be formulated and a set of new techniques should be adopted.

2. Quality and product variety are first priorities.

The alloy and low-alloy steel proportions of our total steel products are lower than international advanced levels. Some kinds of alloy and low-alloy steel which are urgently needed in the national economy are still not enough to meet the demand. The quantity, quality, costs and price of some kinds of alloy and low-alloy steel are less competitive, although we are able to produce them. The mass production of some kinds of steel which are commonly used abroad are still not established although test production has already succeeded. Generally speaking, the production output is still low. The internal and surface quality of our products are far from satisfactory. The life time of products is not long enough and their performance is not fully satisfactory.

Therefore, the quality difference between our products and that of developed countries is the main difference. The policy "product quality and variety first" should be strictly followed so that the situation of our steel industry will be fundamentally changed.

Which species of steels should be first developed?

(1) As far as the alloy steel is concerned, it should be developed proportionally. In the near future, production of alloy structural steel, stainless steel, high speed tool steel, bearing steel and especially cold rolled silicon steel sheets should be emphasized. Meanwhile, new demands from all branches of industry should be met, for example, the steel needed to build 30-60 KW thermal power stations.

(2) As far as the low-alloy steel is concerned, the key product which has a large demand is high intensity steel, such as 60-70 Kg (or heavier) steel rails, reinforcing steel bars, all weather steel and low-alloy oil pipes.

(3) For product variety both of low-alloy and alloy steel, production of steel plates and steel pipes should be developed. The amount of pipes, plates and strips among total steel products should be increased. Product deep-machining should be appropriately developed.

(4) The steel product numbers which already exist in our country should be regulated and reorganized and be serialized as soon as possible. Those species which have good economic profits and have been tested through long time usage and which have been produced steadily and have a good reputation from consumers, we should continue to produce and improve their production. Those species which have poor economic profits, cannot meet the quality standards for a long time, have unstable performance, are costly to produce or are produced by obsolete technology, and have a bad reputation from consumers, should be absolutely discontinued. The most effort should be put into the development of those new steel species which are already acknowledged internationally as mature products. At the same time, small amounts of new species should be created.

What are the targets of the improvement of product quality?

(1) The production processes should be generally organized according to the international advanced standard.

(2) The standards, as long as they are acknowledged internationally and have shown competitiveness in world markets, such as API standard for oil pipes, SKF standard for bearing steel, should be strictly carried out by some better conditioned plants.

(3) Those plants which would start to use international standards or new quality standards should contact their users and negotiate with them first. If there is any disagreement from the users, they should stop using new standards.

(4) Every plant should stipulate its own quality control standards, which should be higher than national standards, to improve the quality of its steel products.

(5) Advanced on-line test facilities should be purchased, produced and set up. Product quality control should be carried on, and the product quality feedback system should be set up. A series of quality guarantee systems, which would permeate research, design, equipment, manufacture, production, testing and application, should be established. Combined with carrying out economic responsibility system and the reform of reward system, product variety and quality should be considered the important conditions for reward.

3. The adoption and development of the new technical level

First of all, we have to make sure we know what is the foreign technical level of the 70's and the beginning of the 80's; also what kind of technical level we are now on. Then we can put our efforts step by step to make ourselves closer to and finally reach the advanced level abroad. Premier Zhao said that by the end of this century the advanced techniques abroad of the 70's and the beginning of the 80's would basically be popularized in our country. According to my understanding, what Premier Zhao meant is that through 18 years effort, most of the key steel plants in our country should reach the level of developed countries. Some plants might still not be able to reach the level, but some might already pass the level and reach an even higher level. In general, this level should practically be reached.

According to today's situation of our steel industry, most low-alloy steel is produced in open hearth furnaces or converters by our ordinary key steel plants, while most alloy steel is produced in electric furnaces by our special steel plants. They belong to two totally different systems. As new technical policies are being formulated, analysis could also be made separately according to these two systems.

First, let us look at the ordinary key steel plants. The technical equipment and technology level of Wuhan 1.7 Meter Rolling Mill and its related factories, such as the secondary steel mill, hot rolling mill and silicon steel factory, and the now being built Baoshan Iron and Steel Complex, are basically representatives of the international level of the 70's. The technical levels of Anshan, Baotou and Benqi, etc., ordinary key steel plants are representative of the earlier years.

Compared with the general level, the advanced one has the following characteristics: the converters work on a more scientific basis and have higher efficiency; the purity of steel is higher; operation is continuous; the steel production quality is better. From the long term point of view, the open hearth furnace would be gradually discarded.

Let us now analyze the difference in alloy steel technologies. Since every kind of alloy steel is produced on the production line of our special steel factory by its own technology, let us take stainless steel production as an example. Compared with the level of the 50's and 60's, the international advanced level of the 70's and 80's has the following advantages: more variety, better quality, high precision, higher final finished product rates (78%) and lower costs.

The procedural diagram of abroad advanced technology is as follows: smelting in high power or superhigh power electric furnaces—————→

AOD or VOD (argon oxygen decarbonization and desulphurization or vacuum decarbonization and desulphurization)—————→

continuous casting—————→hot continuous rolling (controlled rolling)—————→

20 rollers continuous cold rolling (cold rolled steel)—————→
continuous acid pickling—————→polishing and grinding (stainless steel).

Compared with the ordinary level, the advanced one has the following characteristics: the efficiency of electric furnaces is higher; the process done outside of the furnaces is precise; the operation is continuous; rolling and heat treatment are regulated and continuous; acid pickling and polishing are mechanized and continuous. The above-mentioned international advanced level is precisely the level of new techniques and technology we want to adopt.

4. Technique import and digestion should be stressed.

Technique import and digestion is one of the important methods to achieve our targets and the level which we plan to achieve. For ordinary steel, the techniques and equipment imported have already been put in a complete set and the production line and full manufacturing capability have been formed, for example, at Wuhan Iron and Steel Complex, and Baoshan Iron and Steel Complex. While as far as the technical equipment of special steel is concerned, the complete and comprehensive production capability has not been formed although some advanced techniques of the 70's were already imported. The effort should be concentrated to digest the techniques which have already been imported and meanwhile the techniques which we still lack should be introduced from abroad, so that they could be put in a complete set to form a full production capability. The following main techniques should be imported:

- (1) High power and superhigh power electric furnaces
- (2) molten iron pretreatment equipment
- (3) continuous casting equipment for alloy steel billets and square billets (electromagnetic stirring machines should be included)
- (4) cold rolled steel strip high precision mill.

To develop the continuous casting technique and increase its proportion in steel, casting continuously should become an important technical policy in our steel industry.

When we introduce a technique from abroad, we should import its software in particular, that is, to import technical patents, know-how and manufacturing techniques. What the Japanese used to do is mainly to import software and digest it, then develop and create their own patents; finally, their own products were created. Japan has become a technique and equipment export country. They spent less money and have achieved more profit. Their technical progress and development were carried out very quickly and we should learn from their experiences.

According to my own opinion, the experience by which the Japanese have imported technical software can be summarized as the following three points:

(1) Money has generously been spent to import software. Then large amounts of labor, money and material have been put in to digest them. During the period of the large scale introduction from abroad, one dollar was spent to import techniques and, on average, 3-5 dollars were spent to digest them. In order to increase the capability of their products to compete in world markets, the money spent on digestion has been increased to 7 dollars since 1976.

(2) Experts from all fields were organized to digest and develop new techniques. For example, when the comprehensive techniques of blast furnaces, oxygen converters and continuous casting were introduced from abroad the technicians of all the large steel companies were organized to digest them. The results were commonly used. We belong to a socialist society. We have better conditions to organize the experts. Selfishness and technical blocking between different companies should be avoided.

(3) The production department paid a lot of attention to the investigation of technology and equipment. The metallurgy department and machine building department closely cooperated. Equipment should follow the requirements of technology. Only when technology is very well understood and a good idea of technology is created,

new highly efficient equipment can be built. Several large Japanese steel companies investigated not only production technology, but also technology equipment. They can build some specialized equipment, too. The equipment in the steel industry not only has a large amount of variety, but is also very complex. There is no one company which can make all of them. Even a large company, such as the New Japanese Steel Company, uses ordinary equipment manufactured by machine building factories on the one hand; on the other, it builds some specialized equipment in cooperation with specialized machine building factories. Not only all the equipment needed by the steel industry can be manufactured in Japan, new technical equipment is also invented and exported. If not enough effort regarding this were made by us, the technical introduction from abroad would be carried on generation after generation. If it were so, we would have not enough money to spend on that and, technically, there would be no future for us.

5. Treasure and develop our own advanced techniques

Thanks to the common efforts of research, design, manufacture and production units, thanks to the great support, cooperation and coordination from users, some techniques and equipment which are close to or have reached the level of the 70's were created by ourselves. They have been playing important roles in the development of low alloy and alloy steels.

The newly appeared techniques of the metallurgical industry could be summarized as follows:

- (1) AOD argon and oxygen mixture blow smelted stainless steel
- (2) VOD vacuum oxygen blow precision smelted stainless steel
- (3) LF outside vacuum precision smelting furnace
- (4) bearing steel smelting SKF furnace
- (5) steel powder blowing equipment, which increases the purity of molten steel and expands the smelting range of low alloy steel
- (6) electric furnace which uses earlier dephosphorization,

enforced oxygen blowing and inside powder blowing compressed recovery period techniques and can shorten by one hour the smelting period and decrease electricity consumption per ton of steel

- (7) the generalized usages of heat insulated caps and protection slags
- (8) movable water outlets used in steel bar casting
- (9) bricks, which are penetrable to gas, used as fireproof material in steel bar casting and outside furnace treatments

As far as the steel rolling techniques are concerned, the following of our advanced ones can be listed:

(1) hydraulic pressure fine adjustment equipment is applied on steel rolling mills so that the thickness tolerance of wide steel strips is improved (tolerance decreases from $\pm 0.3\%$ to $\pm 0.10-0.15\%$).

(2) "Moderate speed and medium load steel billets grinder" and "water soaked ultrasonic flaw detector" are used in special steel factories.

(3) Rolling technology lubrication is used in cold rolling mills and figured steel plate rolling so that energy consumption is decreased and surface quality is improved.

(4) Centrifugal steel pouring rollers are used. Their lifetimes are comparable to imported rollers.

(5) Continuous annealing in controlled environmental conditions is used in treatment of bearing steel.

The above-mentioned techniques are only some main examples; there are still many unmentioned inventions and innovations in various factories. On the contrary, we should treasure, encourage,

support and develop our own advanced techniques and respect the creative works of our technicians and workers. We should do our best to combine abroad and inland advanced techniques and form a complete, advanced technical system of Chinese characteristic: One of the examples is the Capital Steel Complex whose secondary blast furnace is the result of this kind of combination, and become a first level blast furnace internationally. Among the techniques it uses, the technical patents of the coal powder blowing and the top combustion type hot-blast stove are introduced abroad. For smelting, rolling and heat treatment techniques of special steel and low alloy steel, we could do the same thing to combine the advanced techniques which have been proved to be effective to create a first level technique which is close to or has reached the world's advanced level of the 70's.

6. Investigate and store new techniques

We should not restrict ourselves on popularizing of the mature techniques only. We should look forward to the future and pay enough attention to the development and improvement of new techniques and carry out the related work of technique investigation and storage. According to information from abroad, it might be worthwhile to consider the following technical investigation.

As far as ordinary steel is concerned, new technology procedure appearing in the beginning of the 80's but not yet popularized are, for example:

molten iron pretreatment——→compound blowing and smelting
in converter——→steel refining——→continuous casting and hot
rolling——→continuous cold rolling.

It can be summarized as three-step steel making as far as smelting is concerned. The first step is to pretreat molten iron (desulphurization, dephosphorization, desiliconization). The second step is to compound blowing and smelting and to decarbonize and regulate temperature. The third step is the second refining,

deoxygenation, dehydrogenation and denitrogenation. Compared with the conventional smelting technique, a big leap forward has been made. Even compared with the smelting technique used in the Wuhan and Baoshan Iron and Steel complexes, it is more advanced and more pure molten steel can be achieved.

As far as the steel billet casting and rolling are concerned, continuous operation is achieved. Continuous casting and hot rolling have been combined and a continuous operational line is formed so that the entrant molten steel is continuously cast and then hot rolled to become hot rolled steel coils. A continuous operational line is also used to roll the hot rolled steel coils as cold rolled steel coils. Only through this kind of highly continuous operation, a series of higher level new techniques and technologies to increase the precision of rolling and internal quality of steel could become possible. This set of technology procedures, which is more sophisticated than that of the Wuhan and Baoshan Iron and Steel complexes, is predicted to be commonly used abroad in the 80's. For special steel, for example, there are the following techniques:

(1) If direct current electric furnaces, comparing with alternating current electric furnaces, were used, higher efficiency, lower energy, electrodes and fireproof material consumptions could be achieved, and operational noise would be cut down. The test operations are carried out in Great Britain, Sweden and other countries. It was reported that some successes have been achieved.

(2) New techniques to decrease electricity and raw material consumption of electric furnaces are being investigated. For example, compound cold water electrodes (the upper half is made of steel and the lower half is made of carbon), cold water furnace top and walls are used; oxygen or other combustion-supporting gases blowing technique is used; chemical heat and potential heat of furnace gas are fully utilized; second refining techniques are more often adopted.

(3) Furnace burden and alloy addition are controlled by computers. On-line control is also done by computers.

(4) High power output silicon controlled rectifiers have been investigated and applied.

(5) The technique of steel being outpoured from the bottom of a furnace is being investigated. The advantage of this is that a large amount of cooling water can be used and also the time for removing steel can be cut down. An electric furnace of this kind, which can produce 110 tons of steel, has been put in operation in West Germany; it was reported that fireproof material consumption and heat waste, which occurs during the steel output period, is decreased.

(6) Original discrete operations turn out to be continuous, such as the classification of furnace burden and its pre-heat treatment and continuous input; molten steel continuous output and casting.

(7) Some new techniques of rolling and heat treatment are also being investigated and tested internationally.

For the above-mentioned new techniques appearing at the beginning of the 80's and these being investigated, we should look into them very closely and collect the relation information. Investigation and economic justification should be carried out. Investigation and development should be done selectively and collectively.

7. Technical reform should be carried out on the basis of specialization and reorganization

The development of alloy and low alloy steel depends mainly on the technical reform and enlargement of the old factories. The future development should be based on a new technical foundation. The reform and enlargement of the existing special factories would cost less money and time and achieve results much faster than

building a new factory, so it should become our development guiding principle in the near future.

As the developing trend of alloy steel in the world becomes more and more specialized, the specialization and reorganization should be done before our complete technical reform plan is stipulated. SKF Special Steel Factory in Sweden is well known in the world for specializing in developing bearing steel. The special steel factories in our country should be reorganized according to the specialization principle.

The policy "reorganization first, reform second" should be carried out; specialized production targets should first be determined for every special steel factory, a technical reform plan then accordingly stipulated. Reform should be carried out step by step.

Technical reform in special steel factories should be carried out according to its own conditions. Those factories which have better conditions in energy sources and transportation and also have room to develop should be expanded and reconstructed first.

Time and economic profits should be stressed when technical reconstruction is being carried out. We should do our best to shorten the reconstruction period. Energy consuming technologies and equipment should be reconstructed to energy saving ones.

Residual heat should be fully recovered and used. Energy saving should become a key issue for reconstruction. To make the equipment a complete set should always be kept in mind during technical reconstruction so that the comprehensive production ability can be achieved.

8. A research-production complex should be set up. Construction of a new technical test basis of alloy and low alloy steels should be speeded up.

Abroad and inland experiences both show that only when research design, equipment manufacture, production units and users cooperate closely can new productions, technologies and equipment be put in a complete set and research results be turned into productive power.

Even though there are research results in laboratories, the problem still cannot be solved without appropriate equipment manufacture and production test results and without tests of usage. In order to develop alloy and low alloy steel, several technical development bases inside of the industry should be set up. These bases should become industrial test bases for new techniques, equipment and products of the industry. These bases should become well equipped test factories which are responsible for industrial check-up of the important research projects.

It is the best way, according to experiences abroad, to promote the comprehensive progress in science and technology and better administration of technical development when research, design, manufacture, production and users are organized to form a cooperative complex for a new technical project and one or several factories are chosen as industrial test bases for the whole industry. We should discontinue the situation that research is isolated from production and usage and that only the research results in laboratories are looked upon, and technology and equipment investigation is ignored.

It was suggested that a steel factory should be reconstructed as a new test basis for alloy steel of our country. It was also suggested that a steel factory should be reconstructed as a new test basis for ordinary steel of our country.

Some people also recommended that when conditions are ready in some areas similar bases could be established.

To these bases we should give necessary technical and financial support as well as equipment. This is an important technical organizational measure, and also an important policy to turn research

results into practical productive power.

9. General and advanced techniques coexist and initiatively transform the first to the second

The technical foundation and level of our steel industry, including low alloy and alloy steels, is still rather low, which should be transformed to an advanced level through technical reconstruction and scientific research. It will be a hard task and cannot be done in a short time.

We could say that from now to the end of the century it would be a period of technical transformation of our steel industry from a backward state to an advanced state. We must know clearly that during the period advanced techniques would coexist with general techniques. By knowing this characteristic, the new technical policy could be adopted and developed by grasping the following two factors.

First of all, during the period when new techniques are used, we should be very cautious and patient. Everything should be done according to the financial, technical conditions and the available energy supply and transportation in our country.

Technical introduction from abroad, technical reconstruction and research should be done step by step. It should be allowed that general and advanced techniques coexist and combine to make contributions.

On the other hand, we should do our best to make the transformation to the advanced level of the 70's and the beginning of the 80's. In other words, we should initiate the attitude of relying on technical and scientific progress.

10. Raw material sources should be used in a reasonable and economical way

Alloy elements should be utilized economically and reasonably. Natural laws should be respected. Subjectivism should be avoided.

(1) The fact that there are many multi-mines in our country should be fully appreciated and utilized. The residual elements, for example, vanadium, titanium, rare earth elements, niobium, phosphorus and copper, in molten iron must be comprehensively used.

(2) Tungsten, molybdenum, vanadium, titanium, nickel and rare earth elements are very rich in our country and also easy to excavate. Alloy steels of these elements should be developed.

(3) Manganese and niobium, although very rich, are not pure enough and cost too much to excavate. We should use them economically.

(4) Chromium, of which a large amount is needed, is a very important element for alloy steel and also an important material for defense; it should be used economically and its necessary storage is needed. Cobalt should be used in the alloy steel which is specially needed, and also used economically.

(5) Frugality should be encouraged. Any time smelting could be done by the middle products of smelting, such as nickel iron, molybdenum oxide blocks, white tungsten, vanadium slags, sponge state titanium, etc., the pure products of these elements should not be used.

(6) The elements which are indispensable in quality control should not be canceled or substituted.

(7) Great effort should be taken to develop iron alloy. It is very important to develop its new technique to keep up the development of alloy and low alloy steel.

(8) Measures should be taken to use waste steel as much as possible. The metalized sphere technique should also be developed.

11. "Pure material" policy should be carried out; the advanced test methods should be completed

Last year I went to the Wuhan Iron and Steel Complex to investigate why the rate of finished products of smelting is so low. One of the reasons is that the performance requirement of silicon steel and O8A1 is very high. For example, as far as carbon content is concerned, only 3 points of allowance are allowed, which is very difficult to control; but it can be done in Japan. The main reasons seem to be that our raw material is not pure enough, our measuring meter is not accurate and our workers are not skillful enough.

The quality of the raw material used in steel smelting is really rather poor; some alloy looks like powder and some like blocks; the grain sizes of iron ores and limestones are not uniform; part of calcium lime already turned to lime but not thoroughly. Since the chemical compositions of raw material fluctuate a lot, adjustment can only be done gradually after it is sent into a stove. We have been only concerned with stoves; little attention has been paid to the raw material. Although complaints from workers are heard every day, no determination has been made and no measure has been adopted to change the situation. In order to make better quality steel, raw material and subsidiary material should be supplied according to the strict quality standard. Unqualified material should not be allowed to be put in stoves. A time limit to change should be set up for those who cannot do as required for the time being.

Measuring instruments and test tools are indispensable for scientific smelting. Large scale investigation into ordinary steel factories and special steel factories in these years shows that operations of smelting and rolling in a lot of steel factories are still done according to experiences. Incomplete check-up and inaccurate or unreliable measurements are very common. How can you make good quality steel if you even do not know the quantity of raw material you already put into a stove? Just like raw materia

measuring instruments have been ignored for a long time in many factories.

A decision should be made that the minimum measuring instrument for the machines must be installed and utilized. Some of the important instruments and testing tools which cannot be made by us could be bought from abroad.

12. Electrodes, fireproof material and rollers of high quality should be developed at the same time

As development of low alloy and alloy steels is being carried out, quality and performance requirements for electrodes, fireproof material and rollers become higher and higher. Therefore, electrodes and fireproof material of high quality should be developed at the same time.

For example, if superpower electric furnaces would be used, the transformer capacity they need would increase to 500-600 KVA per ton of steel, or even higher, from 200-300 KVA per ton of steel. Therefore, the superpower carbon electrode whose electricity current density is up to $25-35 \text{ A/cm}^2$ should be developed. In order to do that, the high quality raw material, needle state coke and bituminous coal needed to make superpower electrodes should be developed first. At present, the production of needle state coke must be stressed. The new technologies of high pressure shaping, twice burning and surface coating, etc., should be used.

If the new techniques of outside furnace precision smelting, blow smelting and continuous casting are to be used, the fireproof material should be pure and stable at high vacuum, and also should have excellent performance, such as high mechanical strength under high temperature, high anti-slag and splitting proof properties. The raw material sources of magnesite, alumina and carbon in our country should be utilized. The purity of raw materials should be improved through mine selecting and purification processing.

Artificial material should also be developed appropriately; the technologies of high pressure shaping, uniform static pressure shaping, oscillation shaping and high temperature burning, etc., should be used. Different classes of fireproof material used in different locations should be produced to meet the demands of users and also to cut down the costs of users.

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